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ARTICLE IX.

NOTES ON A MAP INTENDED TO ILLUSTRATE FIVE TYPES OF EARTH-SURFACE IN THE UNITED STATES, BETWEEN CINCINNATI AND THE ATLANTIC SEABOARD.

BY J. P. LESLEY.

Read May 4th, 1866.

VERY little of the topography of America has been published. No large areas have been mapped in such a manner as to show the features of the surface. The State of Massachusetts was trigonometrically surveyed, under the direction of Mr. Borden, in 1830; but the published map of that State, which represents the slopes by hachure lines, fails to show the laws which governed the erosion of its surface, and is defective in details. The State of Pennsylvania was not triangulated; but its topography was carefully studied from 1837 to 1841, in sections or districts, by members of the Geological Survey, under Prof. H. D. Rogers; and these sketch-maps, more or less detailed, were compiled into one State map,* which exhibited, for the first and only time, the characteristic features of the topography of the eastern side of the American continent. Although twenty-six other States of the Union have instituted geological surveys, none of them, with the exception of New Jersey and California, has attempted any elaborate topography. In each case the demands of science were supposed to be satisfied with the tracing and coloring of the geological outcrops in a rude and general way. It is especially to be regretted that that accomplished and lamented geologist, Mr. Percival, did not realize upon paper his exact and exhaustive examination of the surface-features of Connecticut, the State which he surveyed, for it could have been done at that time by himself, with ease; and when done, it would have thrown a flood of light upon some of the most difficult geological structural problems that we have yet to solve.

It is surprising that no State, except Massachusetts, has ever set on foot a general astronomical and trigonometrical survey of its surface. What little of exact determination of latitude and longitude has been accomplished, we owe to the personal labors of Prof. Bache, at first alone, and afterwards with the co-operation of the Coast Survey, of which he is the chief; and to Colonel Graham, Colonel Emory, and other engineers of the U. S. Army, appointed to determine the national boundary lines and to survey the lakes. The last published report of the Coast Survey (Report of Progress for 1863), will show how

* As I have described in my Coal and its Topography, 1856, Philadelphia. The State map was finished in 1841, but not published until 1858.

very far these efforts have fallen short of any general survey of the United States. In fact, they have made no impression whatever upon its vast central area.

It is a portion of this central area that I desire to characterize by the map which I exhibit this evening. I have drawn it on stone, from a photographic copy of a large wall-map, which I constructed at the instance of Mr. T. E. Blackwell, when Managing Director of the Grand Trunk Railroad in Canada, in 1861. One of the most public-spirited and enlightened men that ever crossed the Atlantic, Mr. Blackwell had been occupying himself and ten or twenty assistant observers, for several years, with the meteorological and commercial statistics of the Lake Country, intending to embody these in a memoir on the Hydrology of the St. Lawrence, partly to gratify his own professional zeal and taste for natural science, but more to enlighten his countrymen on subjects connected with the future prosperity of America, of which he was an enthusiastic prophet. Mr. Blackwell's father had been in a previous generation at the head of the profession of civil engineering as applied to canal construction and waterworks in England; and the son, brought up in the pursuits of the father, and inheriting his abilities, was the acting efficient junior member of the commission of three appointed for devising a new system of drainage for the city of London. His untimely death, after a journey in Egypt, where, although a sad invalid, he filled his note-books with the most telling and instructive geological sketches of that country that it has ever been my good fortune to see, prevented the appearance of his memoir before the Institute of Civil Engineers, for which it had been prepared, and was the means of its being published ultimately in the Transactions of the American Philosophical Society, of which Mr. Blackwell had been elected a member only a year or two before his death.

During the final revision of the materials for this memoir, I spent two months, as his guest in Montreal, furnishing him with geological data to exemplify the subject; and our discussions led us to design a second memoir, on the Iron Resources of the United States, to be illustrated by a map, showing not only the positions of the American Iron Works, but also the belts—the geological belts—of ore-bearing formations, upon which their existence depended. This afforded me an opportunity to realize an old and favorite design. Accordingly, I compiled a map of the United States, fifteen feet square, giving my own interpretations of the published topography of every State which exhibited marked features of relief,—basing these interpretations, first, upon the authentic topography of the State of Pennsylvania; secondly, upon my own topographical notes in other States; thirdly, on numerous local and county maps; fourthly, on the better marked portions of the State maps; and lastly, on the colored geological maps of the several States, or parts of States, already published.

The result was very striking. Familiar as I have been for years with the topography

of every part of the United States, and of Canada, east of the Mississippi River, I was surprised at the beauty of the whole representation now for the first time made to the eye. The correlation of parts was very fine, in a geological sense. The plateau of the coal, commencing in Alabama and cut off square by the Hudson, contrasted strongly with the essentially unbroken run of the Quebec Group and Laurentian System, from Georgia to the extreme east end of Canada; while the open valley of the Lower Silurians, everywhere keeping the two systems apart, was most remarkable. The sweep of the Lower Devonian and Upper Silurian escarpments around the end of the Catskill, with their long straight lines through New York and their curve through Western Canada, was likewise beautiful. But the charm of the map lay in its unmistakable utterances respecting different topographical types of earth-surface or strongly contrasted systems of erosion, lying in masses, side by side, or running for long distances in parallel belts.

Thus, for instance, the eye takes in at a glance the whole Blue Ridge, Highland, and Green Mountain belt, full of short sharp ridges, in parallel order, but in echelon arrangement, with irregular summit lines, rising into knobs and peaks from 3000 to near 7000 feet above the sea.

Behind it runs the belt of the Appalachians, composed of interminably long and narrow barrow-mountains, with level summits, seldom 1000 feet in height, looped and gophered in an intricate and artificial style, with lens-shaped coves in the northern part; and on the other hand, in the Southern States, terminating in pairs of perfectly straight ridges, cut off short by faults.

Behind these, again, lies the Great Cumberland-Alleghany-Catskill Plateau, with its horizontal geology and its quaquaversal, arborescent drainage-system, boldly contrasting with the Appalachian topography in front of it, and settling the questions of mode and agency in favor of slow aërial denudation.

Still further west, the low finger-shaped bounding ridges and central plains of the Blue Grass country of Kentucky and Ohio shows another but allied type.

And in the east, the wide belt of low sand-hills, southeast of the Blue Ridge, and the immense cretaceous and tertiary flats of the tidewater country, crenulated with bays and covered with dismal swamps, presents a fifth, differing from all the rest.

This map is now in England. But before it left this country, Mr. Bache obtained permission to have it photographed in sections, in the office of the Coast Survey. And it is one of these sections that I have redrawn on stone and offer as a first specimen of what we have a right to expect when the United States, at peace once more among themselves, and free from the curse of slavery, thank God, shall take up in earnest the work of studying and expressing to the eye the character of the countries which they possess in common. During the Rebellion, however, these topographical section-maps were of a more

pressing interest, for they showed to the Government at Washington what a herculean task it would be to operate with large armies upon the Central Valley of Virginia and East Tennessee, from the Ohio as a base. A glance at this map will explain the long continuance of the Rebellion,—the shifting fortunes of the fight,—the repeated losses of the national arms in Western Virginia,—the necessity for that favorite project of Mr. Lincoln's, a railroad from Louisville to Knoxville, which he was induced to abandon only by the threats of Kentucky,—the peculiarly anti-secession posture of North Carolina, the State of the Smoky Mountains,—and some other points of the history of the last four years,—better than the most elaborate written descriptions alone could do it.

I should be glad to offer the whole map to the Society for publication; but it would not bear reduction to a scale small enough for these Transactions, without losing many of its most interesting features. I have been content, therefore, to select an area which would show the above five specified kinds of topography, and at the same time some of the variations to which two of them are subject, viz.: 1. The broadening of the Blue Ridge belt near its southern end, and its double structure as it runs north into Pennsylvania; and 2. The difference between the looped structure of the Appalachians, about Winchester, and their duplicated straight outcrops, cut off by oblique faults, in the neighborhood of Knoxville.

I have selected this area for other reasons also: the principal one being a hope that it may pique the scientific zeal of some of our younger geologists to study this almost untrodden ground. There are not more than one or two reliable topographical maps of all the area exhibited here, and these are very local. It is a grand field for study, and will bear splendid delineation.

But there is one remarkable feature of this particular area, which holds in reserve, as I believe, the future explanation of one of the largest of our American structural problems—the cause of the rectangular opposition of the southwest- and northeast-outcrop and fault system of the Appalachians to the southeast- and northwest-outcrop and fault system of the lower Ohio, upper Mississippi and lower Missouri region. In the centre of the map it will be seen, that the New River (or Kanawha) heads not, like all the other affluents of the Ohio, on the inside edge or at the brow of the great backbone-escarpment of the Alleghanies, but starts from the recesses of the Blue Ridge, and among the heads of the Atlantic seaboard rivers; that it penetrates the Appalachian belt; and that it finally enters and passes through the Cumberland or Alleghany Plateau, to the Ohio River, by which, in fact, it is continued, almost in the same straight line, to Cincinnati. Now I have no doubt, that with this strangely exceptional thorough-cut, is dynamically connected the 350 fathom fault, which runs parallel to and just north of the New River, and the south side of which carries up the floor of the great Silurian Valley almost to the height of

the surrounding mountains. I must connect with the same feature of surface-topography that whole system of faults (southeast and northwest) to which the asphalt vein of Hughes River and the upthrow of Marietta belong, as well as the northeast- and southwest-cleavage of Western Pennsylvania, the southeast and northwest waves of East Kentucky, the southeast- and northwest-faults which cross the Ohio at Henderson, and the Mississippi in the Burlington region, and the long low island of Huronian and Laurentian rocks, discovered by James Hall, on the Minnesota River, in 1865.

In fact, we see in all this the evidence of a strain or warp given to the earth-crust by some force which has apparently carried down the Azoic and Palæozoic continent under water, toward the south and southeast, permitting the Cretaceous and Tertiary deposits to surround and overlap them in all the Gulf States. It is this warped strain that has snapped our northern anticlinals, and substituted for them downthrow-faults in Southern Virginia and Eastern Tennessee,—the downthrow being usually to the east of the fault, and amounting, in many cases, to the whole vertical distance from the Red Shale of XI (Subcarboniferous) down to the Limestone of II (Lower Silurian).

It is a pity we have none of the minute work yet published, which has been done here and there along the borders of the great coal area, for it would help greatly to explain the true nature of the erosive agency which has relieved an expanse of continent, amounting to one or two hundred thousand square miles (its original limits are unknown), from a superincumbent weight of Coal Measures at least two thousand and perhaps, if capped with Permian measures, five thousand feet in height. It is evident from the map, that the whole of this wastage (with the exception of a small section in the north, drained by the Susquehanna and Delaware Rivers southeastwardly, and by the Genesee and Schoharie Rivers northwardly), has passed off into the Valley of the Mississippi; and thus we can account for a certain due proportion of the Cretaceous and Tertiary deposits of the Southwest. But as these were also products in some measure of an ancient system of short rivers which ravined the eastern slope of the Rocky Mountains along a face of, say, two thousand miles,—and probably also of another, similar, but opposite and shorter system of more important rivers flowing from the Laurentian mountains of Canada westwardly into the same Cretaceous sea,—we must not assign rashly too high a value to the subsidy of deposit paid in by the coal area of the Eastern United States.

We see also that the Cretaceous and Tertiary deposits of the Atlantic coast must have had another origin. And yet this other origin could not be wholly different from the first. For, as the map will show at a glance, the whole Devonio-Silurian (Appalachian) belt, in front of the edge of the arborescently and westwardly drained area of the present Coal Measures, has suffered a still more considerable loss of superincumbent material, the whole of which loss must be represented by the semi-continental area of the flat Cre-

tacio-tertiary tidewater country, through which the rivers, which at first produced it, are still flowing, and extending themselves, as they push forward their deltas, along the present seaboard. Now, from this Appalachian belt, not from two to five thousand feet of rocks, as in the case of the Coal Measures, but from twenty to thirty thousand feet of superincumbent Upper Silurian, Devonian and Carboniferous measures have been swept away, leaving the present floors of Lower Silurian rocks, which constitute the Great Valley (of Winchester, Wythe, and Knoxville), and the other secluded anticlinal valleys behind it. We seem to be restricted by these facts to the conclusion, that the erosion of this Appalachian belt of upturned vertical or steep-dipping Devonian and Silurian outcrops has furnished actually twice or thrice as great a mass of Cretaceous and Tertiary detritus for the Atlantic waters as the Coal Measure areas of the Alleghany-Cumberland plateau has been able to furnish to the great central estuary uniting the Polar Ocean with the Gulf of Mexico in Cretaceous and Tertiary times. What became of all the subsequent wastage which passed down the rivers during Middle Secondary times,—times during which so much of the present Pacific side of the continent was formed:—how far it extends beneath the Atlantic:—how much of it went to form the Central American deposits:—how early began the Gulf Stream to sweep the western wastage round through Southern Georgia and the Carolinas, northeastward, toward New England and Ireland, as it continues doing to-day:—and how much weight we must assign to the third element—the cotemporaneous erosion of the great Azoic (Blue Ridge, South Mountain, Highland) belt, which has always formed a barrier between the disturbed inner Appalachian belt of upturned Palæozoic rocks and the outer floor of gold-bearing Quebec Group (Primodial—Potsdam S. S.) rocks, upon which the Middle Secondary and Cretaceous deposits were thrown down:—are among the questions to be solved by another generation of geologists.

But this much I feel sure of, that the old cataclysmic doctrines cannot be upheld in the light of our present geological knowledge. Erosion by wind and rain, sunshine and frost, slow chemical solution, and spring and fall freshets, has done the whole work. I have long taught that it could not have been accomplished under water level by oceanic currents, because the ocean is a maker and not a destroyer. But I must now abandon wholly the idea to which I have clung, with a slowly relaxing grasp, so many years, that a complete erosion theory demanded some such forces as would have been supplied by the extra efficiency of an ocean translated across the upheaved surface through the air. At the same time, the above considerations make me all the less willing to admit the ice-cake theory of erosion as even approximately true. For if aerial erosion has been going on uninterruptedly ever since the uprise of the Coal Measure continent, how little of the whole effect can have remained over to be still produced at the time when the Glacial epoch set in and the supposed ice-cake began to take the work in hand. The battle has

raged all day; the ground is strewn with the dead; nothing but the rear guard of the beaten army is to be seen; the victors are about to bivouac on the field; now the king's jester rushes forward, waving his sword, and shouting, "Follow me, to victory or death!" We have only to turn our eyes from the dentritic erosion of the Alleghany coal-area, as represented imperfectly upon our map, to contemplate the outspread of Cretaceous and Tertiary country between the Blue Ridge and the sea, to place a proper estimate on the availability of the supposed ice-cake of the glacial era, for sculpturing such continental areas as that of the Coal, reaching from the 43° or 45° down to the 33° or 32½° of latitude, especially remembering how the sculpturing was nearly finished before the glacier was born.

The erosion of the wonderful Green River ravines, in the Colorado country, to a depth of five thousand feet, is not more evidently the product of ordinary meteorological causes than is the erosion of any given segment of the Appalachian or Alleghany districts exhibited upon the map. But the Coal Measure areas show the truth most plainly. The ravines which debouche upon the Blue Grass area south of the Ohio, along a line extending from Portsmouth in Ohio, to Somerset near the Tennessee line, all have vertical walls of Conglomerate (Millstone grit), supporting a sadly wasted Coal Measure country above, and overhanging steep slopes of Subcarboniferous shales and limestone below. This limestone, horizontally outcropping on each side of every ravine, and with a delicate dip towards the southeast, is full of caverns; while sink-holes in the Coal Measure country above show that their ramifications extend beneath the whole surface. Fine springs issue from them; robbers have always haunted them; and guerilla bands, during the late Rebellion, made many of them famous for deeds of blood.

Towards their outlets these ravines are gradually cut down through the Devonian sands and shales into the Silurian limestones next below. An opportunity is thus afforded for the escape of all the waters concealed within a second system of branching caverns belonging to this formation, far larger than the one above. These lower limestone waters are highly magnesian. The underground erosion, the concealed dilapidation of the Silurian limestones by their disintegrating reactionary chemistry, is extensive beyond conjecture and growing daily. A world of natural catacombs must underlie the many thousands of square miles of surface represented by the northwest quarter of the map.

I believe that this chemical element of erosive energy has been slighted even in discussions the most recent. I ascribe to it nine-tenths of the wastage of the Blue Grass area. I believe that the erosion went on, chiefly underground, along those narrow belts where the lime-rock formations approached the surface at whatever level the surface happened at the time to stand. The caverns grew; their roofs fell in; streams washed the debris continually away. As the surface thus kept falling piecemeal into the cavernous traps everywhere laid for it below, the general level of the area was slowly and insensibly let down

to its present grade above the sea. While falling thus, the opposing outcrops of the upper rocks retired from one another, eastward and westward, and let the Blue Grass area between them widen slowly to its present size. And still the work goes bravely on. The Mammoth Cave is only one of many thousands which border the central anticlinal Blue Grass country, crossed by the Ohio River.

The same method of erosion, by caverns and sink-holes, is observable in all the Appalachian limestone valleys east of the coal area, explaining, I think, the depth of their limestone floors, as compared with the sandstone mountains which environ them.

There can no longer be entertained a doubt of the existence of vast sheets of ice upon the surface of this continent at certain epochs. Even changes of sea-level may be calculated by considering what must have been the amount of water necessarily abstracted from the sea at first for their production, and again restored to it at their destruction. But we surely cannot accord even to the heaviest conceivable ice-cake of the glacial or any other era the honor of eroding our topography. Without referring to such profound abysses as the Valley of the Saginay in Labrador, the Yosemite Valley in California, or the new-found chasm of the Albert Nyanza in Tropical Africa, it is sufficient to look at the map before us to feel the absurdity of the suggestion.

If such an ice-cake ever passed over our mountains, it must have had its southernmost limit somewhere along a line drawn through the middle of Pennsylvania. Otherwise, why has no diluvial scratch or groove ever been put on record from any point south of the Turnpike notch in the summit of the Fourth or Peters Mountain, fifteen miles north of Harrisburg? And why do not genuine erratics exist in Southern Ohio? Outcrops in Virginia could receive and should retain striæ quite as well as outcrops in Pennsylvania, for they are in all respects similar. Ice had no hand in Appalachian erosion. All it has done has been done in the north, and its only action was to polish a surface already made. It has left no other trace of its existence. It had no mountain summits from which to receive moraine matter, and no moraine has been as yet discovered out of New England and Northern New York. The northern outcrop-sides of some of our east and west-running (eight to twelve hundred feet high) Appalachian ridges in Pennsylvania, are as uniformly sheeted with angular blocks, detached by frost and tumbled down by slow wastage of supporting shales, as are the southern outcrop-sides of the rest of them. Ice has had no hand in this, except the ice of winters innumerable, that of 1866 included in the count. These angular-stone facings are no moraines; and the solitary alleged moraine, at the mouth of one of the twig vales of a branch of Pine Creek in Northern Pennsylvania, ought to be well studied before it be accepted as a product of anything else than the freshets which carry destruction periodically down along our river-beds.

It has not been my intention to write a memoir on Erosion, but to show how far-reaching those suggestions are which such a map produces to the eye of the geologist.

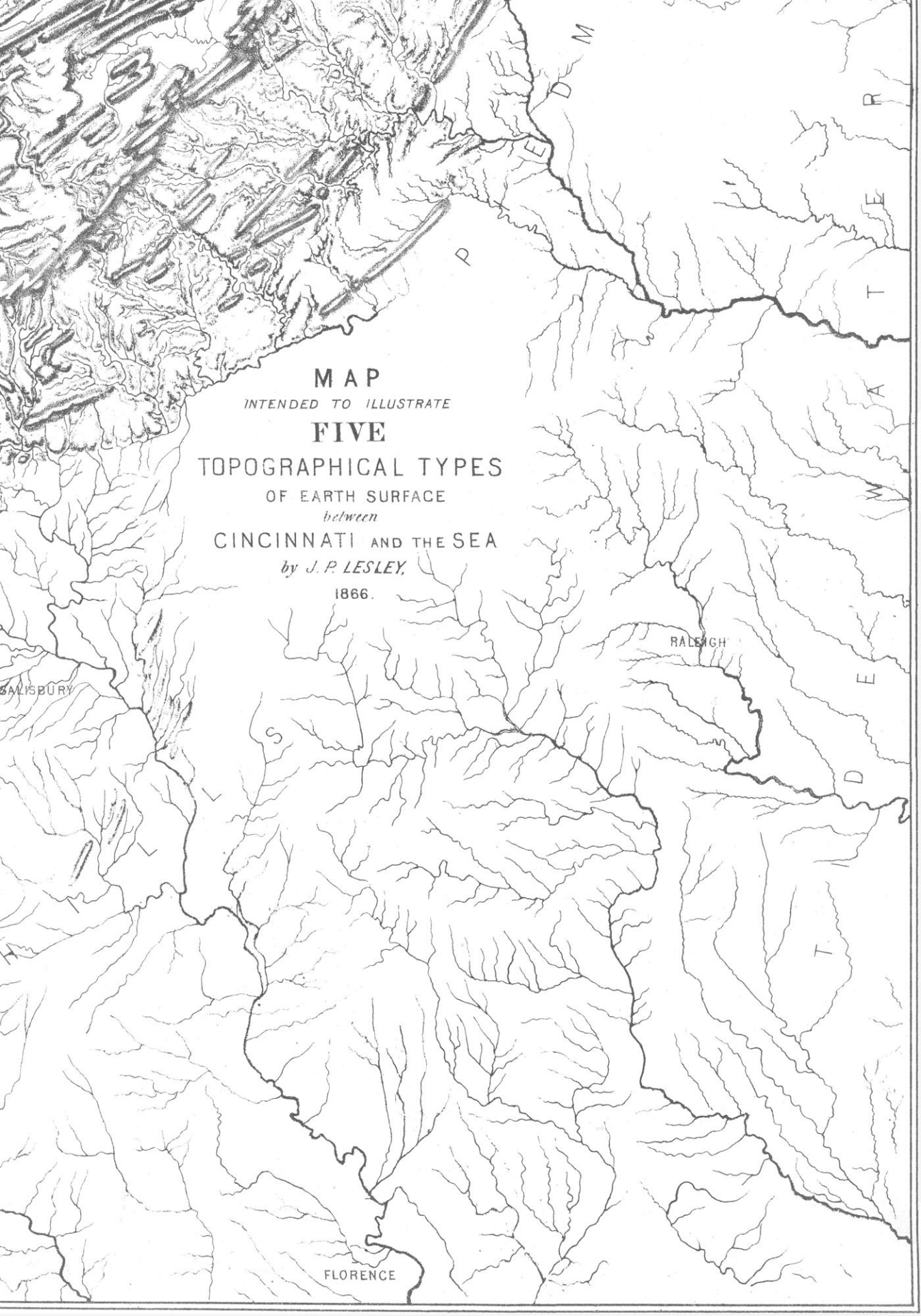

CINCINNATI
PORTSMOUTH
U G R A S S
B A X
SOMERSET
Clinch R.
Holston R.


CHARLES
TON
Greenbrier R.
WYTHEVILLE
TOP


WINCHESTER
STAUNTON
GORDONSVILLE
RICHMOND
PIEDMONT
MAP
INTENDED TO ILLUSTRATE
FIVE
TOPOGRAPHICAL TYPES
OF EARTH SURFACE
between
CINCINNATI AND THE SEA


B
SOMERSET
Clinch R.
Holston R.
French broad R.
KNOXVILLE
Tennessee R.
ABBEVILLE


WYTHEVILLE
SALISBURY
ABBEVILLE


MAP
INTENDED TO ILLUSTRATE
FIVE
TOPOGRAPHICAL TYPES
OF EARTH SURFACE
between
CINCINNATI AND THE SEA
by J. P. LESLEY.
1866.
RALEIGH
SALISBURY
FLORENCE